II Screen File

HEADQUARTERS
ROME AIR DEVELOPMENT CENTER
RESEARCH AND TECHNOLOGY DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Griffiss Air Force Base New York 13442

25X1

REPLY TO ATTN OF: [redacted]

25X1

SUBJECT: [redacted] Report Entitled, "Investigation of Large-Area Display Screen using Liquid Crystals"

15 September 1965

25X1

TO: [redacted]

Dear Dick:

1. Attached is a draft copy of the report on Large-Area Display Screen using Liquid Crystals, requested by [redacted] of your organization on his recent visit. 25X1

2. This report is currently in publication and I will see that you get several copies when it's released. Since this is a work draft of the Project Engineer, we would like it returned within three weeks.

3. Please feel free to copy any parts of interest to you.

25X1

[redacted]

Interp & Analysis Section
Recon Intel Data Handling Branch

1 Atch
Draft cy Investigation L-A Display using Liquid Crystals

Oct 65

25X1

Returned to [redacted] who will send a final copy when published.

Declass Review by NGA

DOWNGRADED AT 3 YEAR INTERVALS; DECLASSIFIED AFTER 12 YEARS. DOD DIR 5200.10

3248

No: wis. form of it!
Borrowed

5 November 1964

Interest
- Exceptions
- Tech. Questions

DEVELOPMENT OBJECTIVES

IMAGE-INTENSIFIER SCREEN

1. INTRODUCTION

These development objectives describe requirements for an image-intensifier screen to be used for rear-projected images.

Rear-projection viewers have come into standard use for scanning and interpreting photo transparencies. Most of these materials are high-resolution and require great enlargement before the human visual system can assess the total information content. This enlargement, in turn, requires greater projection lamp power in order to attain the necessary image brightness over the entire viewing screen. Increased lamp power is accompanied by greatly increased heat incident on the film so that it is distorted or damaged. There are in existence various techniques for cooling at the film plane, e.g... dichroic mirrors, fans, liquid gates, etc.. In spite of these techniques, there remains the heat vs image intensity problem in high magnification projection of film transparencies which are static or slow moving in the film gate.

It has been postulated that this problem might be solved by intensifying the image at the viewing screen. Such a screen would require minimal power in the projection illumination, but would produce a bright image for the viewer.

2. CONCEPT

2.1 Purpose. These objectives describe a development which would overcome the heat versus image intensity relationship characteristic of high magnification (in order of 100X) rear projection viewers.

2.2 Scope. The primary objective is, that under nominal highlight illumination of approximately 10 foot candles, the image-intensifier screen should provide the viewer with an image of adequate gain and brightness while exhibiting satisfactory performance in many other aspects, such as: resolution, tone range, linearity, color temperature, viewing angle, response time, size, life and cost.

A secondary objective is to provide a means for controlling modulation of image contrast, such as tone-reversal and compression or expansion.

3. GENERAL DISCUSSION

The image-intensifier screen is intended for use on rear-projection viewers, which would be used by one to four persons to scan and interpret high-quality photo transparencies at various magnifications (ranging to 100X). The screen size on these viewers maybe as large as 30" x 30". The image-intensifier screen should be designed to require minimum modification of existing viewers.

4. PRIMARY REQUIREMENTS.

4.1 Gain. The gain of the IIS must be such that light within the range of 2800° - 5800° K, falling on the screen at intensity equal to one foot-candle, causes a brightness of 50 foot-lamberts to be radiated throughout a solid angle of 90° (centered on the axial ray). A greater gain is desired -- provided that it does not compromise other performance parameters.

4.2 Emitted Light.

4.2.1 Brightness. The IIS must be capable of emitting a maximum brightness of 50 foot-lamberts; 200 foot-lamberts is the development goal.

4.2.2 Linearity. Gamma. The emitted light must be directly proportional to the incident light at all intensities. Gamma must approximate unity (± 10%).

4.2.3 Brightness should not vary more than 10% (from the theoretical) over the entire viewing area.

4.2.4 Brightness Distribution Lobe. The emitted light should be of relatively uniform brightness (± 10%) throughout a 90° solid angle centered on the emergent paraxial ray.

4.2.5 Color Temperature. The emitted light must fall within the color temperature range of 3500° - 5500°K.

4.2.6 Brightness Levels. The emitted light must display at least ten different, visually distinguishable brightness levels when excited by correspondingly varied incident illumination. As many as twenty different distinguishable levels are desired.

4.2.7 Reflectance. The viewing surface of the IIS shall be designed to minimize reflectance of ambient room light. This requirement is of utmost importance: ideally the viewing surface of the IIS should have reflectance characteristics similar to those of black velvet, in order that maximum modulation transfer can be preserved even in normal room light.

4.3 Resolution. The IIS shall be capable of resolving 10 line pairs per millimeter with a contrast of 100 to 1. The modulation transfer function at 10 lines/mm should be at least 90%: 20 lines/mm at 90% MTF is the design goal.

4.4 Response Time. The IIS must reach 90% theoretical brightness within 10 milliseconds of excitation and must fall below 10% of this brightness level within 10 milliseconds of removal.

4.5 Signal/Noise Ratio. No square inch of the IIS should exhibit a signal/noise ratio less than 100.

4.6 Size. The thickness-and weight-to-area ratio of the IIS should be approximately that of a conventional screen. This IIS may be bread-boarded in 6" x 6" panels. One 12" x 12" operational panel must be delivered. Optional pricing for delivery of a 30" x 30" panel may be given. Feasibility of producing the 30" x 30" units in volume must be indicated.

4.7 Life Expectancy. The IIS must be capable of operating at maximum brightness (at least 50 foot-lamberts) for 200 hours, with no more than 10% degradation in any of the specified performance parameters.

4.8 Power Requirements. The IIS should be adequately served by 110-120 volt, 60 cycle, 15 ampere power supply. Normal fluctuations in the voltage (± 10%) should not perceivably affect performance.

5. SECONDARY REQUIREMENTS.

The following requirements are to be considered if they do not compromise those stated in section 4 (above):

5.1 Contrast Modulation. If the capability is inherent, controllable contrast modulation of the following types is desired:

5.1.1 Complete linear intensity reversal should be available at the option of the operator.

5.1.2 Expansion and compression of the brightness range should be an option available to the operator.

5.2 Monochromatic Sensitivity. The IIS should be sensitive enough to accept illumination from a narrow band of the visible spectrum or the near IR and UV: 6328 A° laser illumination would be a logical consideration. If such were feasible, lens design could be optimized accordingly. In such a case the gain requirements described in 4.1 would be correspondingly.

5X1

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X1 1) [redacted] Proposal — 29 Jan 65

re Channel Amplifiers

Comments as they come:

1. This does not comply with solid state concept — if first

X1 two pages are correct indicator,

[redacted] has proposed a technique which is very similar to those

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X1 proposed by [redacted]

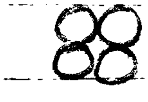
[redacted] etc. We would probably have to resubmit, if we desire to get new channel amplifiers.

2/

2, Pg 2. The hole size would just permit 10 l/mm. The packing density indicates even lower resolution. 6.25×10^8 q/in^2 is what I get for 500 l/mm

$$\therefore \quad \frac{6.25 \times 10^8}{50} = \underline{\underline{1.05 \times 10^7}}$$

is the packing density I get for 10 l/mm ; approx 100 times

X1 more than [redacted] states. This does not account for the gain in dense packing  vice  which would reduce 100 to approx 80.

3/

4. Pg 2. I believe this construction technique is $\equiv$ to one described in [redacted] proposal.

X1

5. Pg 3. I don't buy the $10^6/in^2$ 20 lines/mm relationship.

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6. Pgs 4-5 I believe [redacted], for one, has already answered many of these questions. The fact that the entire screen envelope must be a vacuum tube has been the single factor which has discouraged most people from

considering this concept for III application. The [redacted] 25 fabrication technique does not appear to have any more promise than those mentioned X1 in the [redacted] proposal.

As I recall, [redacted] 25 fails to cite many important basic problem areas that [redacted] 25 contemplated.

5,

6. I believe the main positive statement that can be said for X1 the [redacted] proposal is that they are <u>willing</u> and moderately competent. This combination is, unfortunately, rare.

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